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[Name of Document] CLAIMS

[Claim 1] A processing method of processing a glass base material for an optical fiber using a processing apparatus, the processing apparatus including: a pair of rotatable chucks that directly or indirectly grasp respective ends of the glass base material in an axial direction of the glass base material and that are capable of performing relative displacement in an opposing direction; and a burner for heating the glass base material that is movable along the axial direction of the glass base material being grasped, the processing method being characterized by processing the glass base material while preventing the glass base material from being brought into a cantilever state by always holding or supporting the glass base material at two or more points.

[Claim 2] The processing method according to Claim 1, wherein the processing apparatus includes at least one midway holding device that holds or supports the glass base material at midway part of the glass base material.

[Claim 3] The processing method according to Claim 1 or Claim 2, wherein at least one of the two or more points at which the glass base material is held or supported is midway part of the glass base material.

[Claim 4] The processing method according to any one of Claims 1 to 3, wherein the glass base material is held at two or more midway parts.

[Claim 5] A processing apparatus that processes a glass base material for an optical fiber, the processing apparatus comprising: a pair of rotatable chucks that directly or indirectly grasp respective ends of the glass base material in an axial direction of the glass base material and that are capable of performing relative displacement in an opposing direction; and a burner for heating the glass base material that is movable along the axial direction of the glass base material being grasped; and at least one midway holding device that holds or supports the glass base material at midway part of the glass base material.

[Claim 6] The processing apparatus according to Claim 5, wherein a supporting mechanism of a holding part provided for the midway holding device has a structure of receiving load from the glass base material via a spring or an air cylinder.

[Claim 7] The processing apparatus according to Claim 5 or Claim 6, wherein the holding part includes a roller made of carbon.

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[Document Name] SPECIFICATION

[Title of the Invention] PROCESSING METHOD AND PROCESSING APPARATUS OF GLASS BASE MATERIAL FOR OPTICAL FIBER

[TECHNICAL FIELD]

[0001]

The present invention relates to a processing method and a processing apparatus of a glass base material for an optical fiber, which is used as a raw material of the optical fiber.

[BACKGROUND ART]

[0002]

An optical fiber is normally obtained by drawing a glass base material made of high-purity synthetic silica by a drawing apparatus in a predetermined diameter, and then by coating the surface of the resultant. The high-purity synthetic silica glass base material is formed into a glass base material for an optical fiber by dehydrating and vitrifying a porous glass base material created using a method such as a VAD (vapor phase axial deposition) method and an OVD (outside vapor deposition) method. Hereinafter, thus obtained glass base material for an optical fiber is simply referred to as "glass base material". The glass base material tends to have bending and be of nonuniform diameter. Correction thereof is performed by heating in an electric furnace and an oxyhydrogen flame prior to a drawing process for transforming the glass base material into an optical fiber.

[0003]

The glass base material specifically completes as a base material of an optical fiber by elongation into a diameter suitable for drawing using an electronic furnace, correction of bending and nonuniform diameter using an apparatus referred to as "glass lathe", and then surface cleansing.

Processing using a glass lathe aims to eliminate stains, small scratches, and the like caused on a surface of the glass base material during processing of the glass base material, in addition to correction of the diameter and the length of the glass base material.

Processing of the glass base material is normally performed using a glass lathe as is illustrated in FIGs. 1 and 2. For efficient utilization of the entire length of the glass base material 1, glass supporting rods 2a and 2b are welded to the glass base material 1 at respective ends of the glass base material 1 in the axial direction of the glass base material 1. The glass base material 1 is mounted to the glass lathe by the chucks 3a and 3b grasping the glass supporting rods 2a and 2b.

[0004]

The elongation process is performed in the following way. While the glass base material 1 is rotated around the axis thereof, the surface of the glass base material 1 is

heated from one end thereof along the glass base material with the oxyhydrogen flame of the burner 4. A fixed rotation stand 6 and a movable headstock 7 are distanced from each other until the desired diameter is obtained while measuring the diameter with the diameter measurement device 5.

Cleansing of the glass base material surface is performed by heating the surface by operating the burner 4 while rotating the glass base material with the distance between the fixed rotation stand 6 and the movable headstock 7 being maintained as above.

[0005]

The actual processing procedure is as follows. First, as shown in FIG.1, the glass supporting rod 2a, which is to be welded to one end of the glass base material 1, is grasped by the chuck 3a, faced against the glass base material 1 grasped by the chuck 3b so as to face the ends, and then the ends are heated by a burner 4, to bring the glass base material 1 and the glass supporting rod 2a into contact thereby pursuing welding. During this operation, if the welding is pursued with the cores being deviated from each other, the glass base material 1 will cause bending during processing even if the initial glass base material 1 has not had bending. With this in view, the cores are corrected as necessary for the purpose of preventing core deviation at the contacted portions.

[0006]

Next, as shown in FIG.2, the glass supporting rod 2b is welded to the other end surface of the glass base material 1. While the chuck 3a continues to grasp the glass supporting rod 2a to which welding has been performed first, the chuck 3b is released from the glass base material 1 and the glass base material 1 is removed from the movable headstock 7. Then the chuck 3b is made to grasp the glass supporting rod 2b to be welded next, and the facing ends are heated to weld the glass base material 1 and the glass supporting rod 2b. In this way, the glass supporting rods 2a and 2b are welded to the ends of the glass base material 1 respectively.

[0007]

The elongation process is performed subsequent to this state. In the elongation process, the diameter correction for the glass base material 1 is performed by operating the burner 4 from one end and along the glass base material 1 for heating purpose, and elongating the glass base material 1 by moving the movable headstock 7. During this operation, the heated part is softened by adjusting the flame power and the operating speed of the burner 4 as necessary, and the diameter is adjusted by adjusting the moving speed of the movable headstock 7. After the glass base material 1 has undergone the elongation process and the diameter correction process, the ends of the glass base material are processed into a spindle shape suitable for a drawing start.

[0008]

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The process (hereinafter occasionally "spindle shape process") of forming the ends of the glass base material 1 into a spindle shape is performed by heating the vicinity of an end of the glass base material 1, moving the movable headstock 7 while the burner 4 is halted, and elongating the heated part. As a result, the end of the glass base material 1 are formed into a spindle shape. During the processing, the burner 4 is slightly moved according to a desired form. In this processing, the end is not completely cut off. Instead, the elongation is stopped when the narrowest portion of the elongated part has reached 20-50mm. The other end of the glass base material 1 is also processed into a spindle shape. After the both ends of the glass base material 1 have been formed into a spindle shape, tarnishes, dusts, and the like caused by silica powders remaining as a result of the processing are removed by flame polishing. Thereafter, the glass base material 1 is cut by fusing at the spindle-shaped portions at both ends, thereby completing a glass material ready for drawing.

[0009]

The diameter of the glass supporting rods to be held by the glass lathe is either the same level as or slightly thinner than the diameter of a raw material of the product, according to the thermal deformation at the welded portions. The length of the glass supporting rods is adjusted to such a level for the chucks and the rotation mechanisms of the chucks not to be broken. Specifically, the length is adjusted to approximately 300-900mm, according to a relation with the flame power and the heat directed to the chuck portions during the processing.

[DISCLOSURE OF THE INVENTION]

[PROBLEMS TO BE SOLVED BY THE INVENTION]

[0010]

Recently, the size of glass base material is becoming large, for the purpose of reducing the cost. To be more specific, as the length of an optical fiber that can be drawn at once gets long, the incurred time required per unit length is reduced. Furthermore, the drawing speed becomes faster and the productivity is raised, and so the expense regarding the drawing is restrained. For example, a conventional glass base material having a diameter of 50-80mm and a length of 1000-1500mm has an optical fiber length of 100-600km. In comparison, if a glass base material is designed to have a diameter of 100mm and a length of 1500mm, an optical fiber length approaches 1000km. Furthermore, if a glass base material has a diameter of 120mm and a length of 1500mm, an optical fiber length will be 1300km or more.

[0011]

However, when the glass base material gets large, a burden increases in the processing process prior to the drawing. For example, a raw material having a diameter

of 80mm and a length of 1500mm has a weight of about 20kg. In contrast, a raw material having a diameter of 120mm and a length of 1500mm has a weight of 40kg or more. In addition, the weight of the glass supporting rods that are to be welded to both ends during processing has to be taken into account, too. Such weight increase substantially impedes the processing.

[0012]

As the glass base material gets large, the weight and the length thereof accordingly increase. As a result, the stress at the chucks that grasp the ends increases as well. Each such grasping part is provided with a buffer material for preventing scratches on glass. However the grasping width is about 100mm which is short compared to the length of the glass base material. Therefore when a glass base material is in a cantilever state (i.e. when the glass base material is held at one end thereof, or at an end of a glass supporting rod welded to the glass base material), a slight inclination is caused at the grasping part by the incurred weight.

[0013]

During welding of a glass supporting rod, the length of about 1500-2000mm is brought into the cantilever state. Therefore if there is even a slight inclination at the grasping part, the end of the glass base material to be welded will experience a large deviation from the central axis line of the chucks. Such deviation remains as it is after the welding. The deviation appears as bending during the elongation process and the spindle shape process. In this case, a further bending correction process has to be performed.

Such bending causes problems during drawing. For example, a glass base material is subjected to uneven heating in the furnace, or the glass base material comes into contact with the inside of the furnace. Therefore, existence of bending is an important inspection item regarding a glass base material.

[0014]

When the glass base material is held in the cantilever state, even when a tip of the glass base material does not initially deflect while being rotated, inclination by gravity tends to gradually increase due to change in load position of the grasping part during rotation. When a large and long thing is left rotating in the cantilever state for a long time, it occasionally happens that the deflect at a tip of the thing gradually increases.

After a glass supporting rod is welded to one end of a glass base material, a chuck that used to hold the glass base material is released to make the chuck hold the glass supporting rod in turn for the purpose of performing welding to the other end of the glass base material. During this operation, too, the cantilever state is caused and deflect (deviation) at a tip increases before the welding completes.

[0015]